**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

# MARK SCHEME for the October/November 2010 question paper for the guidance of teachers

## 9701 CHEMISTRY

**9701/21** Paper 2 (AS Structured Questions), maximum raw mark 60

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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**1** **(a)** the actual number of atoms of each element present (1)

in one molecule of a compound (1) [2]

**(b)** $C_xH_y + \left(x + \frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

$xCO_2$ (1)

$\frac{y}{2}H_2O$ (1) [2]

**(c)** **(i)** oxygen/$O_2$ (1)

**(ii)** carbon dioxide/$CO_2$ (1)

**(iii)** 10 $cm^3$ (1)

**(iv)** 20 $cm^3$ (1) [4]

**(d)** $C_XH_y + \left(x + \frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

10 $cm^3$ 20 $cm^3$ 10 $cm^3$

1 mol of $C_xH_y$ gives 1 mol of $CO_2$

whence $x = 1$ (1)

1 mol of $C_xH_y$ reacts with 2 mol of $O_2$

whence $\left(x + \frac{y}{4}\right) = 2$

and $y = 4$ (1)

molecular formula is $CH_4$ (1) [3]

**[Total: 11]**

**2** **(a)** $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (1) [1]

**(b)** temperature between 300 and 550°C (1)

correct explanation of effect of temperature on rate of formation of $NH_3$ **or** on position of equilibrium (1)

catalyst of iron **or** iron oxide (1)

to speed up reaction **or** to reduce $E_a$ (1) [4]

**(c)** manufacture of $HNO_3$
**or** explosives
**or** nylon
**or** as a cleaning agent
**or** as a refrigerant (1) [1]

**(d)** fertiliser in rivers causes excessive growth of aquatic plants/algae (1)

when plants and algae die $O_2$ is used up/fish or aquatic life die (1) [2]

**(e)** **(i)** CO by incomplete combustion of the hydrocarbon fuel (1)

NO by reaction between $N_2$ and $O_2$ in the engine (1)

**(ii)** CO toxic/effect on haemoglobin (1)

NO toxic/formation of acid rain (1) [4]

**(f)** **(i)** platinum/Pt – allow palladium/Pd **or** rhodium/Rh (1)

**(ii)** $2CO + 2NO \rightarrow 2CO_2 + N_2$ (1) [2]

**[Total: 14]**

**3 (a) (i)** a compound which contains **only** carbon and hydrogen (1)

**(ii)** separation of compounds by their boiling points (1) [2]

**(b) (i)** high temperature **and** high pressure (1)

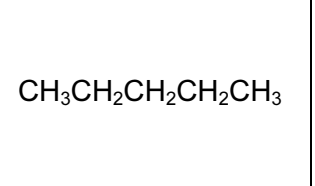
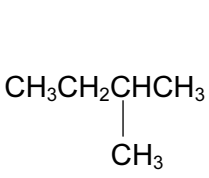
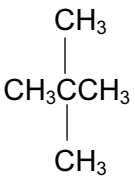
high temperature **and** catalyst (1)

**(ii)** $C_{11}H_{24} \rightarrow C_5H_{12} + C_6H_{12}$ **or**

$C_{11}H_{24} \rightarrow C_5H_{12} + 2C_3H_6$ **or**

$C_{11}H_{24} \rightarrow C_5H_{12} + 3C_2H_4$ (1) [3]

**(c) (i)**

|  |  |  |
|---|---|---|
| isomer **B** | isomer **C** | isomer **D** |
| (1) | (1) | (1) |

**(ii)** the straight chain isomer (isomer **B** above) (1)

it has the greatest van der Waals' forces (1)

because unbranched molecules have greater area of contact/
can pack more closely together (1) [6]

**(d)** enthalpy change when 1 mol of a substance (1)

is burnt in an excess of oxygen/air under standard conditions
**or** is completely combusted under standard conditions (1) [2]

**(e) (i)** heat released = m c $\delta$T = 200 x 4.18 x 27.5 (1)

= 22990 J = 23.0 kJ (1)

**(ii)** 23.0 kJ produced from 0.47 g of **E**

2059 kJ produced from $\frac{0.47 \times 2059}{23.0}$ g of **E** (1)

= 42.08 g of **E** (1)

allow ecf in **(i)** or **(ii)** on candidate's expressions [4]

**(f)** $C_3H_6$ = 42

**E** is $C_3H_6$

for ecf, **E** must be unsaturated and be no larger than $C_5$ (1) [1]

**[Total: 18]**

**4 (a)**

| | | |
|---|---|---|
| reaction 1 | reagent | NaOH/KOH (1) |
| | solvent | $H_2O$/water/aqueous (1) |
| reaction 2 | reagent | $NH_3$/ammonia (1) |
| | solvent | ethanol/$C_2H_5OH$/alcohol (1) |
| reaction 3 | reagent | NaOH/KOH (1) |
| | solvent | ethanol/$C_2H_5OH$/alcohol (1) |

[6]

**(b)** with $CH_3CH_2CH_2CH_2I$ rate would be faster (1)

C-I bond is weaker than C-Br bond (1)

C-I bond energy is 240 kJ $mol^{-1}$, C-Br bond energy is 280 kJ $mol^{-1}$
data **must** be quoted for this mark (1) [3]

**(c)**

| | |
|---|---|
| non-toxic | non-flammable |
| volatile/low bp | unreactive (any 2) |

[2]

**(d) (i)** when a covalent bond breaks the two electrons in the bond are shared between the two atoms (1)

**(ii)** $CCl_2F_2 \rightarrow CClF_2 + Cl$ (as minimum)

allow $CCl_2F + F$ (1) [2]

**(e)** they are flammable (1) [1]

**[Total: 14]**

**5 (a)** NaBr/sodium bromide [1]

**(b)** $Br_2$/bromine or $SO_2$/sulfur dioxide [1]

**(c)** concentrated sulfuric acid is an oxidising agent
**or**
phosphoric(V) acid is **not** an oxidising agent [1]

**[Total: 3]**